

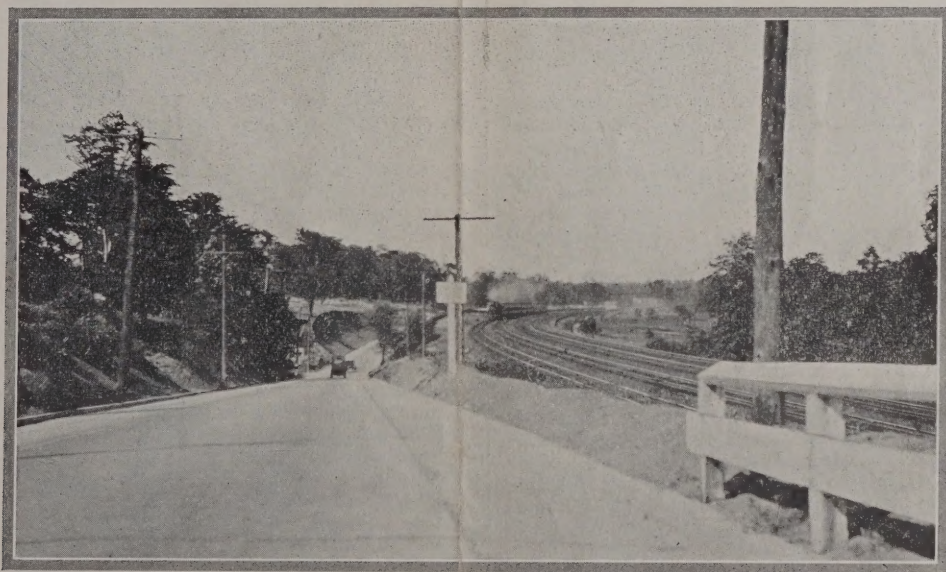
The Highwayman

Route 3, Absecon-Egg Harbor

June
1922

Road Builders' Supplement

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No. 11



Not less important than the rails of steel is the modern hard-surfaced highway in carrying the nation's traffic. "Menlo Park Cut"; Route 1, Section 3

Roads

The Honorable James H. MacDonald, former State Highway Commissioner of Connecticut, was one of the pioneers in the good roads movement in this country. He helped organize the American Road Builders Association. His talk on the development of roads in this country is just as interesting to the layman as to the engineer. *Read it!*

Note

The papers presented at the recent Convention of the New Jersey Highway Association, and the discussions following them, are such a valuable contribution to the progress of road-building that it has been decided to publish them in full with as many as possible of the charts and illustrations used. (It has not been possible to include all of these, however, so there are occasional references in the text, to photographs and charts which have not been reproduced).

Our aim is to publish one or two of the Convention papers, with the discussion thereon, each month. We suggest that these be carefully filed, so that the reader may keep the complete set, which will make a very valuable addition to his road-building library.

This month we are printing "Highways", by Hon. James H. MacDonald, Former State Highway Commissioner of Connecticut; and also "Precautions Necessary for the Proper Application of Glutrin to Gravel Roads", by Maurice R. Young, Contractor. Next month there will be published "Improvements Made During 1921 in the Construction of Concrete Pavements", by L. N. Whitcraft, Portland Cement Association; and the discussion thereon at the convention; also "Maintenance of Macadam Roads", by W. A. Van Duzer, Assistant Maintenance Engineer, Pennsylvania State Highway Department; and the discussion thereon at the convention.

The Highwayman

"Highways"

By

Hon. James H. MacDonald

(Former State Highway Commissioner of Connecticut)

COL. WHITEMORE: It gives me pleasure, Gentlemen, not only to introduce the next speaker, Hon. James MacDonald, Former State Highway Commissioner of Connecticut, but to also announce that he is an honorary member of our Association.

MR. MACDONALD: Mr. Chairman and Fellow Delegates. I hardly know just what to say about this whole matter. It is ancient of days, and I had understood from Brother Wasser that the gentleman bearing the same name as I do—a little more acceptable, however,—the Director of the Public Works at Washington, was to have this for a subject, and I only learned upon the arrival of the little program that the substitution had been made. So I appear here as a sort of disappointment.

"Highways" is ancient of days. It is a large subject to treat of by an elderly gentleman, and yet they tell a story about a MacDonald who was an Austrian prisoner. He got talking with one of the Austrian Officers, and he, of course, like all MacDonalds, was rather proud of his ancestry, so they began telling about different things connected with the early days. He happened to speak about the flood and Noah. The Austrian Officer remarked that he had looked over the list of those who came over in the Ark and did not notice anyone by the name of MacDonald. "Well, you know," the prisoner said, "The MacDonald's would never go with such a crowd. In those days the MacDonald's had boats of their own." It gives us a little antiquity.

I am not a stranger to New Jersey nor its history. I have been highly honored by your Civil Service Board for several years, examining your candidates for highway construction,—some three hundred,—and I am very proud to be here today as your guest and also as a brother member, as I understand that you have voted me as an honored member of your splendid Association. I am also delighted to be here by reason of the fact that probably I am the oldest Commissioner, in point of service to my State, in the country. Hence, I am delighted to be here to speak to you today in the Mother State that started this great movement throughout the country.

New Jersey was the first State in the Union to adopt "State Aid", and I am proud to say that I have known all of your Commissioners from Mr. Budd down to the gentlemen who so acceptably fill the office of Commissioner today, and I have been a personal friend also of Mr. Robert Meeker, who serves you so acceptably in his new position. I think Mr. Meeker was at our Convention of the American Road Builders Association in 1904, and has been closely identified with the movement ever since. I enjoyed the friendship of your Commissions, so I feel very much at home, in fact, when I come to New Jersey I find myself involuntarily looking at my feet to see whether I am in my house slippers or my patent leather shoes, I feel so very much at home.

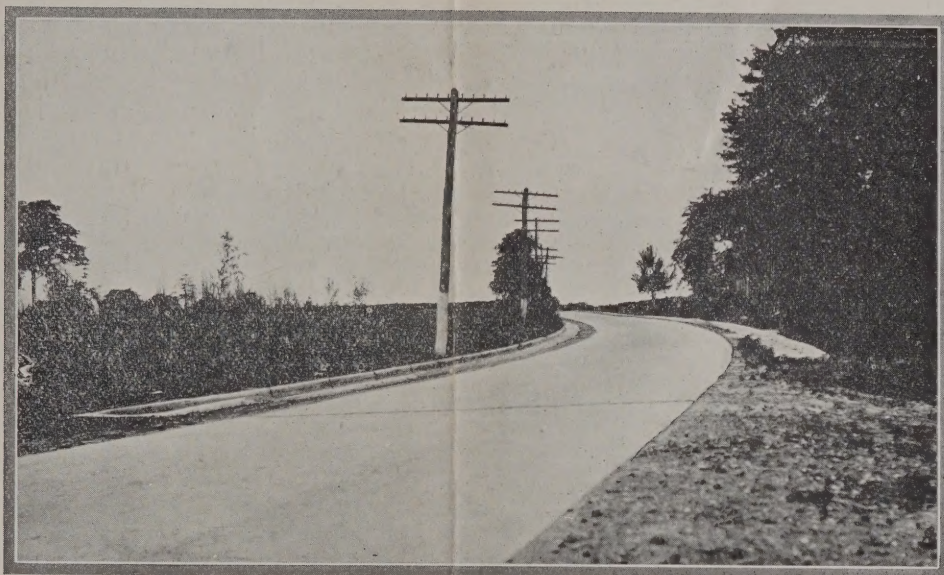
Several years ago, they tell the story, that there were some miners who, upon hearing there was gold on a desert island, went there in search of it. They dug over the entire island, disturbed the entire surface, looking for gold, and came away disappointed. They did not find any. The birds of the air came and brought seeds of pomegranates, grapes, figs, and so forth. The whole island, which was then a desert, blossomed as a rose and bore fruit luxuriantly. The miners builded better than they knew. New Jersey, when she started this movement thirty years ago, builded better than she knew. This great coun-

try owes a debt of obligation to this great little State that it will be very difficult for it ever to repay. I know that when I started in my own State to construct highways, it was not as it is today. We had not gotten very far from the early days of building roads. They had not learned to dis-associate intelligently and economically the money placed in the hands of the several members of select men, some 750 men. They changed every year 60 or 70.

I shall never forget when I started in 1895 as Highway Commissioner of that State, little dreaming of the great task that was before me to bring these people out of the darkness into the light and let them see the error of their ways, to build roads that would be economical roads—roads that would stand the effects of travel and be economical to their interest. The attitude when I went into the several towns was very antagonistic. As a little illustration of how I was received—indeed, how a good many early Commissioners who started in the early days were received, I would like you to hear a little introduction I had in a small town in my State. They had a Doctor in this town who was a graduate of the University, who evidently preferred being a big toad in a little puddle than a little toad in a big puddle. He introduced me in somewhat the following manner: "Gentlemen, we have gathered together for the purpose of discussing this good roads question. As for myself I do not know anything about it, but I have talked with gentlemen who do know something about it, and they told me this is a political job, gotten up to furnish some politicians with a large salary and nothing to do, and I am happy to say we have with us the Chairman of that Commission, who will now address you."

I remember we were very well content to take the \$75,000 that was for use over the entire State—what some States are now spending on a mile of road, take that \$75,000 for 168 townships, 8 counties and distribute it intelligently, so as to build roads economically as a start. In some towns—I know because I had the apportioning of the money—we had to take \$1,000 and divide it up into eight or ten parts, putting a little wooden culvert in here, taking out a large rock there, taking out a sharp curve at another place, or some little thing to gradually bring the people into accord with the movement. So it went on, opposition on all sides until finally they began to wake up and see the dawn of a new day.

So today I find that it is a great deal like MacPherson looking for his relative. MacPherson went up to the Sergeant of a certain regiment and asked if there were any MacPhersons in the regiment. The Sergeant said, "We have about 150 MacPhersons." "Well," he was asked, "Have you any by the name of John?" "We have about 100 by the name of John." "Have you any with red hair?" "We have about 80 with red hair." "Have you any with one eye?" "We have about 50 with one eye." "Have you any with the itch?" "Oh, Lord, the whole regiment has it." That is about the way this movement occupies a thought with the people of today. There is no question at all about the popularity of the movement, the same as the little fellow who never saw his grandfather or grandmother. His grandfather had died and his mother told him one day that his grandmother had come to see him on his birthday. Johnny was washed up and fixed up. His grandmother said, "Well, Son, I think I am your grandmother on your father's side." "Well," said Johnny, "Grandmother, you'd better wake up, you're on the wrong side."



Roads like this have revolutionized the tremendously important business of transporting you from one place to another, quickly, safely and conveniently
Robbinsville-Windsor; Route 1, Section 3

Anyone who takes opposition to the movement, would be taking the wrong side.

Take as a good illustration with what we have to say regarding this great movement, a bar of iron worth \$5.00. Make it into horse-shoes and it will be worth \$12.00. Make it into needles and it will be worth \$350.00. Make it into pen-knife blades and it will be worth \$3,000. Make it into watch springs and it would be worth \$250,000. The same \$5's worth of iron! It requires a great deal of hammering and pounding and polishing to bring it down to the difference between the horse shoe and the spring in the watch. So I take this great movement which means so much to the people of this country, that you can take your earth road and put it into the position of the horse-shoe worth \$12.00. You can take your gravel road and put it in the position of the needles worth \$350.00. You can take your macadam road and put it in the position of the blades of the knife worth \$3,000, and take your higher class roads and compare them with the \$250,000 or watch springs. Each one, in their turn, has accomplished that for which they were intended. I do not discredit a good earth road, I do not decry in any way the construction of a gravel road, nor do I lose sight of the fact that I have built many many miles of splendid macadam roads, and I could have entered into the discussion this morning very acceptably by saying the last official contract I let was to put another surface upon a macadam foundation. I do not propose to in any way assume a partnership with any of the people who are and have been represented on this platform, but the purpose of my little talk is not to be antagonistic or to treat any pavement unfairly, but in the discussion of this question I propose to say those things that have come to me, that in my official work have commended themselves through a long life of active, close association with this good roads movement. So close that I need only allude to one incident, not in a vain glorious spirit, but as a school that I have been allowed, in the long years of my life to attend. I was one of the original organizers of the American Road Builders Association, when there were only five of us to organize that great Association. Nearly all through the existence of that great Association I have had as a companion in my work my friend and your official, Mr. Meeker.

I have lived long enough to see that original five in the organization of that Association grow into one of the greatest conventions ever held in the history of the world, last month at Chicago. Over \$300,000,000 in machinery and in material organizations occupying 70,000 square feet of space to make the exhibit, with an attendance of 5,000 people at their sessions. Not to say anything about the

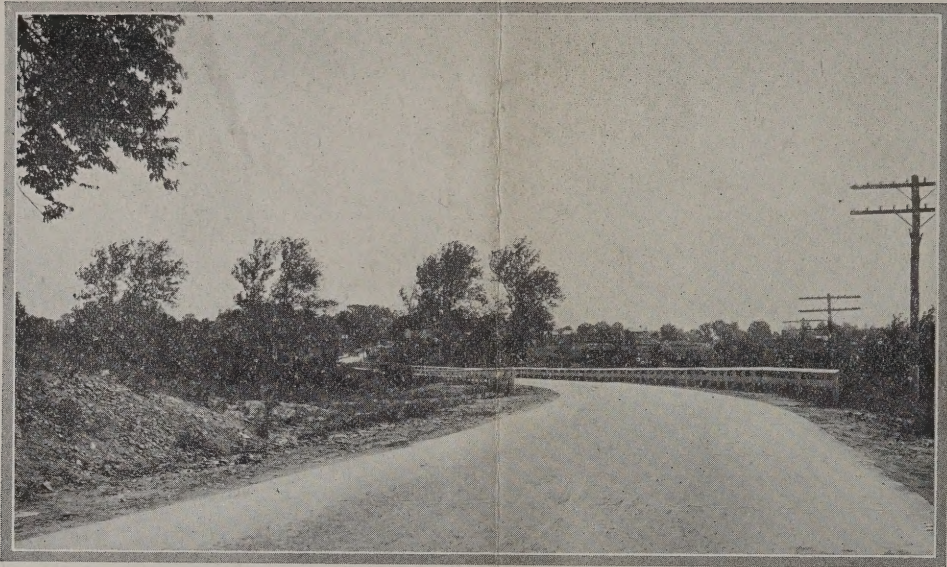
propaganda that the Association has been a part of all over the United States, from the Atlantic to the Pacific, from the Lakes on the north to the Gulf on the south, and the great number of people who have been administered to directly by the delegates and members of that Association, so that in discussing this question I simply take the education and the experience that has been presented to me by close personal contact.

A macadam road, when properly built, is a splendid road to take care of the traffic that it can sustain. A gravel road is a good road to drive on and will take care of the traffic it has to sustain, and when properly built is one of the most satisfactory roads and one of the most resilient roads, and when properly constructed and given the maintenance it is entitled to, will give the greatest service and be the equal of any road that is constructed. And so with the earth road. I remember, and many of you will remember, that when we started this great country that the people all settled at the water side, the river, the lake, and the ocean, and that was the only place that they could settle, and they moved from place to place with the roads. This great country was a wilderness, and from its earth and rock, roads have grown one of the most wonderful machines on the earth, and those rocks have been made to give up greater treasures than ever possessed by the Queen of Sheba. So take your hat off to the early settlers and those gravel roads.

This country was made by this transportation from the depths of time to grow into this great nation that it is. Since then, when we come to 1900, when we started to build this great system that we occupy today, and spend millions of dollars, we have to remember that we are not as far ahead of the dirt road, the gravel road, or the macadam road, as we should be with the waste of money, the experience and the education that we have gone through, with all the foolishness and folly of wrong construction. They did not know how to build roads, and if they had had that degree of intelligence that we have, they would have known the material from which to build these concrete roads.

We are spending today thirty, forty, fifty and often seventy-five thousand dollars for a mile of road. For a mile of road! Outside the city of Washington there is a road from eight to ten miles in length completed by the Army Engineers during the war that cost \$75,000 a mile. What would they have done if they had had the money at that other time I speak of to build the roads. So I say, as the country town, so the city streets. Highway officials on the city streets have nothing

The Highwayman



Traveling a road like this, one is able to take in the beauty of the passing landscape. (Note the color band on pole at right, which informs you of the direction in which you are going.

Toward Windsor, Route 1, Section 3

to say in regard to the construction, to the foolish construction, so called, that has been done in the country towns. Had our cities here in the East built their city streets like the city streets of our Western States are being laid out today, of which every street constructed would have its building line established before they put anything on it. How many times have you gentlemen seen, even in your own state, pavements that were only suitable to be put on a commercial street, and a business street laid on a residential street and vice versa, simply because someone in power wanted a fine smooth, noiseless pavement in front of their own shop. The engineer in charge was not always to blame because he was compelled by the position he held and controlling interests, to pass judgment against his own opinion to the contrary.

"Each man is a world to other worlds half known;
Turns on a tiny axis of his own;
His full life's whit is a pathway dim;
To brother planets who revolve with him."

So I say when we speak of one part of our country, let us line up the city street as well as the country road. There is another thing we do not want to lose sight of, and that is this, that in the building of our roads we are simply extending a city street. Starting at the farm-yard door, the little farms were cut up, the passageway was made after the property became more valuable. Encroachments were made. So many of our country roads are wider today than our city streets, with great congestion of traffic. Let us see to it that what we do in the future with the great amount of money placed in our hands, that we build our roads wide enough to take care of the traffic. Let us see to it that the foundation upon which these roads are constructed are deep enough to carry the traffic. We know what the traffic will be. There is no excuse now. We want good foundations but do not build your foundation any unnecessary depth to take care of traffic.

But if you find you have 5, 10, 20 tons to carry, do not put your foundation 6 in. or 8 in. deep, put it in 12 in., 15 in. and 18 in. deep, if necessary. The surface is a simple matter in the end. In all highway construction in the State of Connecticut, I spent 65% of the money in my hands for the acquisition of right of way, on the question of drainage of the road, and the question of cutting back, that is the sight line, so the line of vision extended for the future and it was a very wise provision when we came into these war times, because my splendid successor, Charles Bennett, would have had very much more difficulty if he had had to build roads with labor at that time. I paved the way for the future. To take care of the alignment, I would recommend not less than 20 feet on main highways, with no shoulder less than six feet. There is no

question about that today, and we have to have it. I am glad that Mr. Meeker is in the Right of Way Division, and I hope the State will place in his hands sufficient money so the people will be glad to give the right of way and start here in the Mother State to build roads so that they will be standards for every State in the Union.

I sometimes extend my talk a good deal longer than I intend when I am on this subject. Regarding the question of bonding! You can give some men all the money there is in the Bank of England. It would make no difference to those men; it would be wisely expended, economically expended and carefully thought out. You could give other men a less amount of money and every penny of that money would be carelessly spent. My own idea about that matter is that they should settle on the money in connection with this bonding scheme. No bonding scheme in the world ever should be longer in its life than that for which the money was appropriated, whether a road or a building. I am a great believer in paying as you go. It is a good thing. Just the same, I am a great believer that every road should be built to carry the load. There is no question about that.

I remember that we used to have a trial test to see whether an automobile could make a hill and established a maximum grade of 5%. Today there are grades of 5, 10, 15 and 17% that are not prohibitive. The question of the future will be foundations, width of road, sight line, drainage, and I believe the best foundation that anybody can build today to take care of the present day needs is to go back to the ancient road and construct a well-built Telford road that will stand any surface put on top of it, built the same as we built them years ago and built the same as you build them here. Have the foundation not less than 12 in. deep. Lay the stone in courses. Break the joints and wedge them good and solid. I have no use for a flat road. Give it the same crown as on the outside top. Don't let the water get under your pavement. There should be plenty of such drainage and see to it that when you build your roads, you put everything in good condition so that it will be in keeping with the material with which it is incorporated.

Inspectors on the roads in the United States are not adequately trained and not carefully trained. Not many states do as you do here in New Jersey, bring inspectors up before your Civil Service Commission. I was retained by your Civil Service Commission to examine some 300 candidates to give them the benefit of my experience and pick out the best men and make the oral examinations a test of ability and to properly impart road construction in your State. Unless you do this, you are always going to be in danger of faulty inspection. I am not going to say any



Like the bed of a railroad, the modern highway is banked at the curves, to protect both the traveler and the surface of the road. (Route 13, Section 1.)

more. I always try to say some particular thing so it will remain in the minds of my hearers and do a little good. I hope some thoughts advanced may have accomplished that result. I thank you for your kind attention.

COL. WHITTEMORE: I feel sure we are all very much edified at this eloquent presentation of the thoughts of Mr. MacDonald in connection with highways. It is an old saying, which I think you will endorse in this instance, when you will also agree that "Out of the fullness of the heart the mouth speaketh." A man must know what he is talking about to be so eloquent in presenting his ideas, as the speaker who has just finished making his address.

I would like to emphasize a remark made by Mr. MacDonald, which is to the effect, as I gather from his words, that of the many elements that enter into the construction of the highway there are only two that are permanent. That is, the location and the drainage. They are the two elements that are nearest to being absolutely permanent and it is well for us all to try to keep in mind those facts when we are called upon to determine where a road shall be located and how it shall be built with respect to its line and profile. I think we are to be heartily congratulated that we had the opportunity of listening to a man of such wide experience and eloquent powers of presentation of his ideas.



The Highwayman

Glutrin for Gravel Roads And the Precautions Necessary for Its Proper Application

By Maurice R. Young

For many years the value of Glutrin as a road binder for gravel, sand-clay and stone roads has been recognized by the Highway Departments of the various states, until, today, it ranks among the standard materials for use on these types of roads. However, little has been written about this material and increase in its use has been due more to the successful results secured than from any publicity campaign.

The base of Glutrin is sulphite cellulose extract, which is a product of the pulp mills and is obtained from the digesters after the wood fibre, known as cellulose, has been removed. This cellulose liquor, as it comes to the Glutrin plant, is of about the consistency of water. It is run into tanks and treated under a special process to remove acids and other injurious materials, which might be in the basic product. After this purification the liquor is run into huge evaporators where it is condensed to a density of 3° Beaume, which is 50% solid.

It is necessary to exercise great care in the preparation of this product so as not to destroy the organic matter, as it is this which makes it of great value as a binding material.

Regardless of whether a road is built of stone, gravel, sand-clay, or earth, there must always be an adhesion or bond between the particles or pieces that form the body of the road and the surface. The strength of this bond varies according to the material employed and the care used in building. Upon the strength of the bond depends the value of the road, and, therefore, any element or substance which can be introduced to enhance the strength of the bond, naturally increases the wearing qualities of the road.

It may be well to state definitely at the beginning that Glutrin will not make a bad road good. In other words, it must have the benefit of proper construction in all details of drainage, selection of materials, and filling of voids, to produce best results. Given this foundation it may be said briefly, Glutrin will produce a thoroughly dependable road, with a firm hard surface, which has at the same time, sufficient resilience and elasticity to withstand the stresses due to temperature changes.

Being applied in a watery solution, its action on the aggregate produces a deep bond. As long as the road is damp and there is any motion of the aggregate, this production of the bond is renewed. With the drying of the road, this action ceases, the bond hardens and becomes strong. A rain or a heavy dew dilutes the unused Glutrin in the road and the formation of the bond goes on again. It will be appreciated from this that the action of glutrin is intermittently continuous, the amount of the bond increasing with each step until the Glutrin is entirely consumed. This explains the fact that glutrin-bound roads become harder as they become older.

When gravel or sand clay roads are to be treated with Glutrin, they should be scraped or harrowed. All loose sand should be removed and all the depressions filled with good gravel before any glutrin is applied. Unless this is properly done it is impossible to obtain good results. The glutrin is mixed with water in order to secure proper penetration and the mixes used vary from half Glutrin and half water to 1 part glutrin and 4 parts water. The glutrin then penetrates into the road and forms a very hard bond. The penetration will continue for some time after the application has been completed as it has a peculiar creeping quality much like that of ink on blotting paper, thus resulting in an increasing depth of the hardened surface of the road.

As you all know, it is necessary for gravel and sand-clay roads to absorb a certain amount of moisture, for, if they entirely dry out, the material will eventually break up. Glutrin retains its cementing qualities for a long time, but however, it will absorb enough moisture to permit the road to be dragged after rain and, when the loose material so dragged is packed down, the Glutrin will recement

this to the original road material. This is an important feature on gravel roads, as they are bound to develop some ruts and holes from time to time.

This quality of absorbing moisture is also of great advantage in making a Glutrin treated road practically dustless. A light rain or even a heavy fog will revive the life of the glutrin and keep the road dustless for a long period of time.

Glutrin has been used by the State of New York on gravel roads for the past twelve years and in Orange County all the gravel roads have been maintained with Glutrin for this period.

Glutrin has been used by the State of New Jersey on gravel roads in increasing quantities for many years. It was found that the roads so treated remained in excellent condition during all the months of the year, while the untreated roads, both in early and late winter, were seriously affected by alternate freezing and thawing and became so lumpy and full of ruts as to be practically impassable. During the season of 1921 all gravel roads in the state system were treated with Glutrin. The roads were scraped and dragged and put into good condition, by the State.

Immediately after the dragging had been completed the company supplying the material applied the Glutrin with their large pressure distributors especially constructed and equipped for laying this material.

The manufacturers of Glutrin own and operate their own tank car lines and were, therefore, able to keep plenty of material at the various railroad stations so no delay was experienced in the treatment of the roads.

In the treatment of gravel roads it has been found that in most cases the quantity of Glutrin required is not less than 6-10 gallon to the square yard and that the mixture should be one part Glutrin to two or three parts water. These figures, however, necessarily vary with the quality and density of the road material.



Discussion on Mr. Young's Paper

(As Mr. Young was not able to be present, Mr. Hurt took his subject.)

MR. SEABROOK: Any questions?

QUESTION: I would like to ask the gentleman if he could tell me how far the material penetrates after the first application, that is penetrates the road.

MR. HURT: The penetration is as stated in the paper. It depends a great deal upon the density of the road and dilution used for the application. It will penetrate anywhere from 6 to 10 inches.

QUESTION: Regarding the harrowing of a road, would you recommend harrowing a road this year for next year's application?

MR. HURT: I would recommend that you put the road in shape every time before you make the application of glutrin in order to get the best results. The method of harrowing depends on the condition the road. If in a rutted condition, the thing to do is to get the ruts and holes out.

QUESTION: Is it any advantage in harrowing the road and then rolling it before the application of glutrin?

MR. HURT: You can do this, but it is not necessary as the traffic will iron it out.

QUESTION: I thought perhaps it might prevent ruts from trucks.

MR. ROBBINS: I would like to ask Mr. Hurt a question or two. He has already answered one of my questions as to the depth of penetration. I would like to know what covers the depth of penetration.

MR. HURT: The compactness of the road and the dilution of the treatment. The more the glutrin is diluted,

of New Jersey

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the further the penetration, the more compact a road, the slower the penetration.

MR. ROBBINS: What do you consider the proper percentage of proportion of the solution?

MR. HURT: As stated in the paper, from one (1) to three (3) parts water to one (1) part glutrin.

MR. ROBBINS: Covered by the density of the road?

MR. HURT: Yes.

MR. ROBBINS: There is a certain amount of clay in our gravel roads. What is the limiting amount of clay binder?

MR. HURT: 15%.

MR. ROBBINS: What is the minimum?

MR. HURT: You get the highest tensile strength with 15%. As low as 2% will increase the material from 12 pounds to 65 pounds tensile strength; with 15% clay at 1-25, one part Glutrin and 25 parts sand-clay, gives a tensile strength of 230 pounds. Practically the strongest material I ever tested.

MR. ROBBINS: What do you consider the minimum quantity for a square yard?

MR. HURT: .6 gallons.

MR. ROBBINS: For 15% clay content?

MR. HURT: Yes.

MR. ROBBINS: What do you consider the maximum quantity that should be put into a road. Pardon me, you have answered that, it depends upon the density.

MR. HURT: Yes.

(Mr. Seabrook was called out at this point. Col. Whittemore took his place.)

COL. WHITTEMORE: I have heard a great deal in the papers about the use of Glutrin, and the use of the Lignin Binder which it is claimed is as good as the other, only one costs more than the other. I would like you, if you will, just to please explain briefly what is the essential difference between the material treated called Glutrin and other material which has not been so treated which is known as Lignin Binder.

MR. HURT: I will only go as far as to say what Glutrin is. We take Spruce wood, cut it in chips and put it under pressure with a solution of Bisulphite of lime and mag-

nesia. 50% remains undissolved as cellulose or wood pulp, and the other 50%, which is used by nature as a binder to hold the wood together, will go into solution. From a ton of wood there is about 1000 pounds of paper pulp produced and 1000 pounds of binding solution, which nature used to hold the wood together. This solution is drained off from the pulp as it comes from the digester. It is treated to remove acids and is concentrated until there is about one-tenth (1-10) of the original volume left. That is the binder which we know as Glutrin. As for the other materials on the market, we do not manufacture them, and I cannot tell you how they are made.

COL. WHITTEMORE: They all come from this one product of the paper mills.

MR. HURT: There are different methods in the manufacture of paper and I am not familiar with the materials you refer to, to such an extent that I could say how they are prepared or made.

MR. TERRY: I think the gentleman explained this very well. You were inquiring as to Lignin Binders compared with Glutrin. It just occurred to me that what you were trying to arrive at was: is Lignin Binder a trade name covering all of them, and was Glutrin a special process of manufacturing by one company? Lignin Binder is the general term for all binders coming from paper mills. We call them sulphide liquors which is the general term of those products coming from sulphuric acid, which makes pulp and comes out of the pulp and is known as lignin binder. It is made at the paper mills where they use sulphuric acid. It is this residue or Lignin Binder when made into a binder after 90% of the water is driven off that becomes the Lignin Binder. It was originally called sulphide liquor. Different companies manufacture it under different trade names. I believe that what you were trying to arrive at, is: Are there different kinds of lignin binders? They are, I presume, sold under different names, but they are all arrived at in that one way and all are used for the same purpose.

MR. HURT: There is no sulphuric acid used in the process of manufacture. Sulphurous acid is used, which is much less strong.

COL. WHITTEMORE: We will now proceed to the next subject.



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